

Washington Park

ARBORETUM BULLETIN

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Concerning This Issue . . .

Spring has arrived, and I hope that the out-of-doors leaves you time for the Bulletin. We continue with articles looking at foreign shores as Tim Hohn takes us to the Mediterranean, pointing out plants suitable for our own area. Then, switching hemispheres, we have the first of two articles about the Marshall Islands, with special interest in the effects of nuclear testing on the vegetation.

And finally, don't miss our exposé that could be subtitled "Everything You Ever Wanted To Know About Tent Caterpillars." Read and get better acquainted with one of our old friends of the garden and wild. Look for our regular features—*In the Arboretum*: lots of work going on; *Book Reviews*; and a new addition, *News On The Shelf*: a column from the E. C. Miller Library at CUH, telling us about books either new or of interest.

Speaking of additions, our congratulations to our regular editor, Nancy Pascoe, who is at home with her own new spring addition—daughter Phaedra. As temporary editor I want to thank all the folks at the Arboretum and CUH for their help while I put this issue together. Happy digging and look for summer, with our special issue on pollen!

Palma Hoppel
Editor



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The Washington Park

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THE COVER

Illustration of the Stone Pine, *Pinus pinea*, at Glenthorne in north Devon,
from *Veitch's Manual of Coniferae*, by Adolphus Kent.

London: James Veitch and Sons, Ltd., 1900.

Courtesy of the Rare Book Room of the E. C. Miller Library,
Center for Urban Horticulture.

Plants of Winter-Rain Regions II: The Mediterranean

TIMOTHY HOHN

It seems fitting that we begin a detailed examination of the climate and vegetation of winter-rain regions with the Mediterranean, as it is the definitive metaphor and largest of the five winter-rain regions of the world. Because the Mediterranean region is the cradle of western civilization, the influence of mankind upon vegetation is nowhere more pronounced, with the possible exception of the impending destruction of the tropical rainforests. Furthermore, many medicinal, culinary, and garden-worthy plants have been selected from the Mediterranean flora over the centuries. For the purposes of this article I will discuss briefly the climate and vegetation of the Mediterranean winter-rain region as well as take a look at a few of the woody plants which may be of horticultural interest for the Pacific Northwest.

Climate

According to the Walter winter-rain circumscription,¹ the Mediterranean climate prevails throughout the basin of the Mediter-

anean Sea including most of the Iberian peninsula, Italy, the Balkan peninsula and all islands. Also included in the climate type are the Atlantic coasts of Portugal, Spain, Morocco, and the Black Sea coast of Turkey and portions of the U.S.S.R. The exception to this range are parts of the Egyptian and Libyan coastlines that are exceptionally dry and fall within the desert climate. Winter-rain climate extends deep into the Middle East in a narrow band all the way to Afghanistan. The area of greatest concern for this article is the basin of the Mediterranean Sea and adjacent highlands. (See map.)

The climate of the region is most strongly influenced by a persistent oceanic high pressure system, the Azores High. Other influential air masses are cold Euro-Siberian air which affects winter low temperatures in the north and eastern portions of the region and hot Saharan air which affects summer high temperatures throughout the Mediterranean. Generally speaking, the climate tends toward greater aridity and higher average temperatures as one travels from northwest to southeast. This trend is locally modified by variations in topography and distance from the sea. West coasts and western flanks of mountain ranges generally receive

¹See article "Understanding World Climate—A Treasure Chest Unlocked," by Dr. Clement Hamilton, *Arboretum Bulletin*, Summer, 1986.



Typical of the western Mediterranean, Arbutus unedo.

photo: B. O. Mulligan

more rainfall (the Dalmation coast of Yugoslavia receives 4500 mm of rain while the Adriatic coast of Italy receives only 508 mm). Typically, as one ascends in altitude, not only does precipitation increase but temperature decreases. This has the effect of limiting the Mediterranean winter-rain climate, in some areas, to a rather narrow band close to the Mediterranean littoral, as in certain parts of southern France.

Those areas of the Mediterranean winter-

rain region with a climate most similar to the Pacific Northwest are located along the northernmost limit in Europe and at certain locations within mountain ranges. As a whole, the climate of the Mediterranean region is most similar to that of California, particularly the central and southern parts of that state, because of a more prolonged summer drought and higher average temperatures than we experience in the Pacific Northwest. Nevertheless, as Dr.



Winter-rain climate area indicated by shading.

Hamilton noted in his article,² the physiological range of plants in cultivation is often greater than their ecological range in nature. Therefore, we are able to successfully grow many plants from the Mediterranean region in the somewhat colder and wetter Pacific Northwest. The winter-rain climate is stressful to indigenous plants because of two major factors: summer drought and winter cold. As a result, the most favored times of growth are in spring when the soil is moist and temperatures are rising, and in autumn just after the first rains when the soil is warm.

Vegetation

The vegetation of the Mediterranean region is dominated by deep-rooted, sclerophyllous woody evergreen and deciduous plants; tuberous, bulbous, cormous perennials; and annuals. Needless to say, the vegetation is strongly adapted to winter rain and summer drought which, by the way, can have significant horticultural implications. Dormancy is primarily a summer phenomenon, particularly among herbaceous plants.

Broad divisions can be made between the western and eastern Mediterranean with two species of *Arbutus*—*A. unedo* (western) and *A. andrachne* (eastern), regarded as typical indicators. Increases in altitude and distance from the moderating effects of the sea generally dictate the ranges of various plant communities. Evergreen oak woodlands (*Quercus ilex*, *Q. suber*, *Q. coccifera*) and maritime pine woodlands (*Pinus halepensis*, *P. pinaster*, *P. pinea*) predominate on the coastal plain areas. Further inland and at higher elevations communities of deciduous oaks (*Quercus pubescens*, *Q. faginea*, *Q. cerris*) predominate in that cooler, wetter environment. The highest elevations and alpine regions of the Mediterranean are occupied by distinctive coniferous forests of pine (*Pinus nigra* subspecies) and fir (*Abies pinsapo*, *A. cephalonica*). Other familiar garden plants are either components of the above communities or form minor floral associations of their own, such as the Italian cypress (*Cupressus sempervirens*) and the Atlas cedar (*Cedrus atlantica*) communities.

The long history of civilization in the



Coning branch of *Cedrus atlantica* var. *glauca*.

photo: William Eng

Mediterranean region has resulted in a prolonged and intensive influence on the vegetation. Consequently, little remains of the original vegetation described above and the most distinctive and widespread vegetation is that of the dwarf bush communities resembling the California chaparral. The main factors contributing to the establishment and persistence of the communities are: 1) the cutting of trees for fuel and charcoal; 2) livestock grazing, particularly goats; 3) agriculture, particularly olive orchards; and 4) fires. As a result, much of the vegetation described above has been reduced to the bush community known as *maquis* (mah-kee'), from the French for "thicket." Further degradation of the *maquis* leads to a more suppressed community of shrublets, forbs and grasses known as *garigue* (gah-reeg'), from the French for "wasteland." The *maquis* and *garigue* formations are home to many familiar herbaceous garden plants, including many bulbs. As woodlands are reduced to bush communities the accompanying erosion only speeds the process of degradation. The exposed red soil, or *terra rosa*, reminiscent of the red clay of the southeastern United States, is a dry, iron-rich soil that develops under evergreen vegetation, is acid in reaction, and is prominent in the Mediterranean region.

²Ibid.

Mediterranean Plants: A Select List

This section will address some general horticultural considerations concerning the culture of plants from the Mediterranean winter-rain region and include a selected list (all too short I'm afraid) of representative plants of horticultural merit with comments on their natural community affiliations and possible landscape uses.

It is unfortunate that many gardeners and horticulturists do not take the time to gain an understanding of the ecological context within which many of their favorite garden plants grow in the world. This information can contribute immeasurably to their understanding of the needs of those plants under cultivation. Insight into particular aspects of plant function, growth, and overall health can be gained, to our advantage as gardeners, if we would take the time to learn about the natural history of our garden plants.

The climate, soils, and communal relationships of plants in the Mediterranean region should provide us with clues for their successful cultivation in the Pacific Northwest. Growing plants from the Mediterranean should prove relatively easy with careful consideration and selection. There are three primary limiting fac-

tors affecting the successful growth of Mediterranean plants in our area: excessively cold temperatures, large amounts of rainfall and/or irrigation and, to a lesser extent, lack of summer heat. Most of the difficult Mediterranean plants in our area succumb to either extreme cold and/or root rot due to excess moisture from summer irrigation or poorly drained soil. Tender species should be sited in protected areas with southern exposure; in fact, most plants from the region should be given full sun. Well drained soils are recommended and, for many plants such as *Cistus*, a high degree of fertility is not necessary and can be deleterious. Plants of winter-rain regions do not ordinarily require summer irrigation and should be grouped with similar, "low maintenance" plants. In a nutshell, given the lavish amounts of horticultural attention heaped upon some of the more common elements in the Pacific Northwest landscape, many plants from the Mediterranean are easy to grow.

Some plants of the Mediterranean are quite ubiquitous and cosmopolitan in their community affiliations. Unless otherwise stated, these plants comprise the major part of the following list.

- *Olea europaea*, Olive. One of the best known and recognized small evergreen trees of the region, olive is thought to have been introduced from the Middle East. Olive forms a maquis association with carob, *Ceratonia siliqua*, in the hottest and driest locations. Only semi-hardy in the Pacific Northwest, olive prefers a sunny south wall. The gnarled form and grey foliage make it a useful plant for textural and color interest in the landscape. Consider it as a companion for red-foliaged and blue-lavender-pink or yellow-orange flowering plants. The white garden at Sissinghurst Castle, in Kent, England, is centered around a large olive tree.

- *Laurus nobilis*, Bay Laurel. The laurel is a common broadleaved evergreen tree in the understory of many woodland communities and prefers northern slopes and moist areas; thus some protection from full sun is appropriate in the garden. Dense and upright growing as a small tree or large shrub, laurel is often used as an element in formal gardens and hedges.

- Evergreen Oaks, *Quercus ilex* and *Q. suber*. Both of these oaks form the canopy of coastal evergreen oak woodlands although the holm oak, *Q. ilex*, is predominant throughout



Flowering *Laurus nobilis*.

photo: B. O. Mulligan



Pinus pinea in Washington Park Arboretum.

photo: B. O. Mulligan

the region with the exception of the eastern Mediterranean. Usually overlooked as shade trees, these are two of the most desirable evergreen oaks for the Pacific Northwest. The holm oak is more upright and dense while, in contrast, the cork oak, *Q. suber*, is rangier and more open in habit. Both of these trees can be expected to attain a moderate size in our area.

- *Acer monspessulanum*, Montpellier Maple. Most common in the deciduous oak woodlands, Montpellier maple usually grows in the understory or shares the canopy. An open, round-headed tree of medium stature, *A. monspessulanum* resembles the hedge maple, *A. campestre*, with the exception that its leaves are 3-lobed rather than 5-lobed. It is an excellent street or shade tree for the small property.

- *Sorbus torminalis*, Mediterranean Mountain Ash. A deciduous tree reaching 40 feet in height, *S. torminalis* is a striking mountain ash of the deciduous woodlands forming groves among the broken canopy of oaks. The boldly cut, plantanus-like leaves of shiny green are the dominant ornamental feature. The fall color is usually a spectacular warm yellow or crimson. Like many *Sorbus*, this one can be expected to produce off-white flowers in loose corymbs during spring and early summer. The fruits are an undistinguished brown. As a single specimen or grouped in front of conifers, *S. tor-*

minalis is a handsome landscape plant.

- *Pinus pinea*, Italian Stone Pine. The Italian stone pine forms exclusive forests along the coastal plain of the northeastern Mediterranean in the warmest areas. In my opinion, it is the most attractive of the maritime pines of the Mediterranean because of its distinctive form. It has a very picturesque, flattened crown and is often referred to as the umbrella pine (not to be confused with *Sciadopitys*). Young trees are tender in our area, but given a chance to mature, they are perfectly hardy. *Pinus pinea* makes a striking specimen in the landscape, alone or with groups of pyramidal hollies, horizontally branched shrubs such as *Euonymus alatus* "Compactus," and smaller weeping plants such as *Leucothoe fontanesiana*.

- *Cercis silaquastrum*, Judas Tree. Probably the showiest spring flowering tree in the region, *Cercis* forms (primarily in the eastern Mediterranean) coppices in the light gaps of deciduous oak woodlands and maquis. It is much more tolerant of drought than other species in this genus—known as redbuds. As a garden plant it has many outstanding features; such as a twisted, picturesque form; rounded, heart-shaped deciduous foliage showing yellow fall color; pea-like flowers on leafless stems (cauliflory) that create a rosy mist of spring color. It is a useful specimen or patio tree. Consider using *Cercis* with blue-foliage and yellow-flowering plants such as conifers and *Cytisus* species (brooms).

- *Arbutus* species, *A. andrachne* and *A. unedo*. As the generic name indicates, both of these species are closely related to *Arbutus menziesii*, the Pacific madrone. Both of the Mediterranean species of *Arbutus* are wide ranging broad-leaved evergreens although their provenance typifies the subtle variation between eastern and western Mediterranean elements. Both of them grow in the understory of evergreen and deciduous oak woodlands and are major components of maquis. At maturity *Arbutus* is an attractive, open crowned small tree or large shrub that is very adaptable to Pacific Northwest landscapes. *Arbutus andrachne* flowers in the spring and has orange-red, peeling bark while *A. unedo* flowers in the fall and has a darker, less peeling bark and hairy twigs. Both species have white, pieris-like blossoms. Consider using it in the garden in combination



Viburnum tinus, Washington Park Arboretum.

photo: B. O. Mulligan

with plants of blue-green, red-bronze, or golden foliage or flowers.

- *Viburnum tinus*, Laurustinus. One of the most common elements in the Mediterranean landscape, laurustinus is most abundant in the understory of maritime pine and evergreen oak woodlands as well as maquis. Laurustinus, like *Arbutus unedo*, needs no introduction to Pacific Northwest gardeners; it is an easily grown, reliable garden shrub or small evergreen tree. Spice up this old landscape favorite with other shrubs and perennials of pink, blue, and chartreuse color combinations.

- *Phillyrea* species. Belonging to the olive family, Oleaceae, and closely allied to *Osmanthus*, *Phillyrea* has two species very common in the understory of maritime pine, evergreen oak woodlands, and maquis: *P. angustifolia* and *P. latifolia*. These are undemanding shrubs deserving of greater garden usage as structural components for the landscape. *Phillyrea latifolia* has a fine, billowy texture due to its closely spaced, small, rounded, opposite leaves, superficially like those of *Ilex crenata*. *Phillyrea angustifolia*, as

the specific epithet implies, is distinguished by its narrow, lanceolate evergreen leaves similar to the simple-leaved acacias, or *Callistemons*.

- *Erica arborea*, Tree Heath. A semi-hardy shrub in the Pacific Northwest, the tree heath is an occasional member of the shrub layer of the maritime pine and evergreen oak woodlands as well as maquis. The tree heath produces fragrant, white flowers in spring, effectively extending the heather bloom begun earlier by *Erica herbacea*. Consider garden combinations of *Erica arborea*, or the hardier variety *alpina*, with coarsely foliated green or variegated plants, including grasses.

- *Cistus* species, Rock Roses. Rock roses thrive on neglect and, indeed, virtually require conditions inhospitable to other plants. They are a major component of the field layer of many Mediterranean plant communities, particularly the highly degraded garigue. They love hot, dry, depauperate sites. In the garden, excess fertilizer and irrigation will cause them to become rank and flowerless. These plants are useful small-to-medium size evergreens for hot, dry banks,

walls, and rockeries with junipers, grasses, sedums and other appropriate companions.

- *Cytisus battandieri*, Atlas Broom.

Restricted to the Atlas Mountains of Morocco where it can be found in the shrub layer and on exposed ledges in deciduous oak woodlands, the Atlas broom has been neglected as a landscape plant in this country. It is more commonly used in Britain, where it is pruned to avoid becoming lanky or is often trained on a wall. This deciduous broom has remarkably distinct foliage which is trifoliate with large, silvery down-covered leaflets. The flowers are delightfully fragrant, golden yellow, and borne on blunt spikes in June. Imagine a red brick wall adorned with *Cytisus battandieri* intertwined with the pink flowering *Rosa* "Madam Gregoire Staechlin."

- *Lavendula stoechas*, French lavender.

Though not as well known as the common lavender, *Lavendula angustifolia*, French lavender is a wide-ranging species in the drier areas of the western Mediterranean. It can be found in the field layer of maritime pine, evergreen oak woodlands, maquis, and garigue formations. French lavender is a downy plant with an inflorescence more notable for its purple bracts than for its flowers. It is a suitable plant for borders and rockeries that grows to a height of 1-2 feet.

The Mediterranean winter-rain region, though somewhat more extreme in winter-rain characteristics than the Pacific Northwest, supports a diverse flora of useful, adaptable plants for our landscapes. ✂



Cistus purpureus

photo: E. F. Marten



photo: Whitie Marten

*Cytisus battandieri in full, yellow, fragrant bloom.
Inset showing ripening seed pods.*

photo: B. O. Mulligan

The Return of the Voracious Herbivore

A.B. ADAMS

A.B. Adams is a doctoral candidate in the Botany Department at the University of Washington.

Sometime between mid-March and early April, an apparently innocuous frothy gray mass encircling twigs of broad-leaved deciduous trees of the Puget Sound area, starts to seethe with life. Within a few days, hundreds of small caterpillars may hatch from this egg mass and form a social aggregation or colony of siblings. Sometime over the next two weeks the buds of deciduous trees burst open and the leaves expand. The simultaneous hatching of these larvae with the onset of rapid leaf production is dreaded by most gardeners and horticulturists because this synchronous awakening of plants and insects may result in a nuisance for many, while being utterly disgusting to others.

The beast to which this article refers is the infamous tent caterpillar (Lasiocampidae: *Malacosoma*) which occurs throughout northern temperate latitudes. How can this tiny creature with a very short life span, have such a bad reputation? Is this notoriety justified? Are drastic control measures needed to keep it in check? Or is the best solution simply to sit back and let nature take its course?

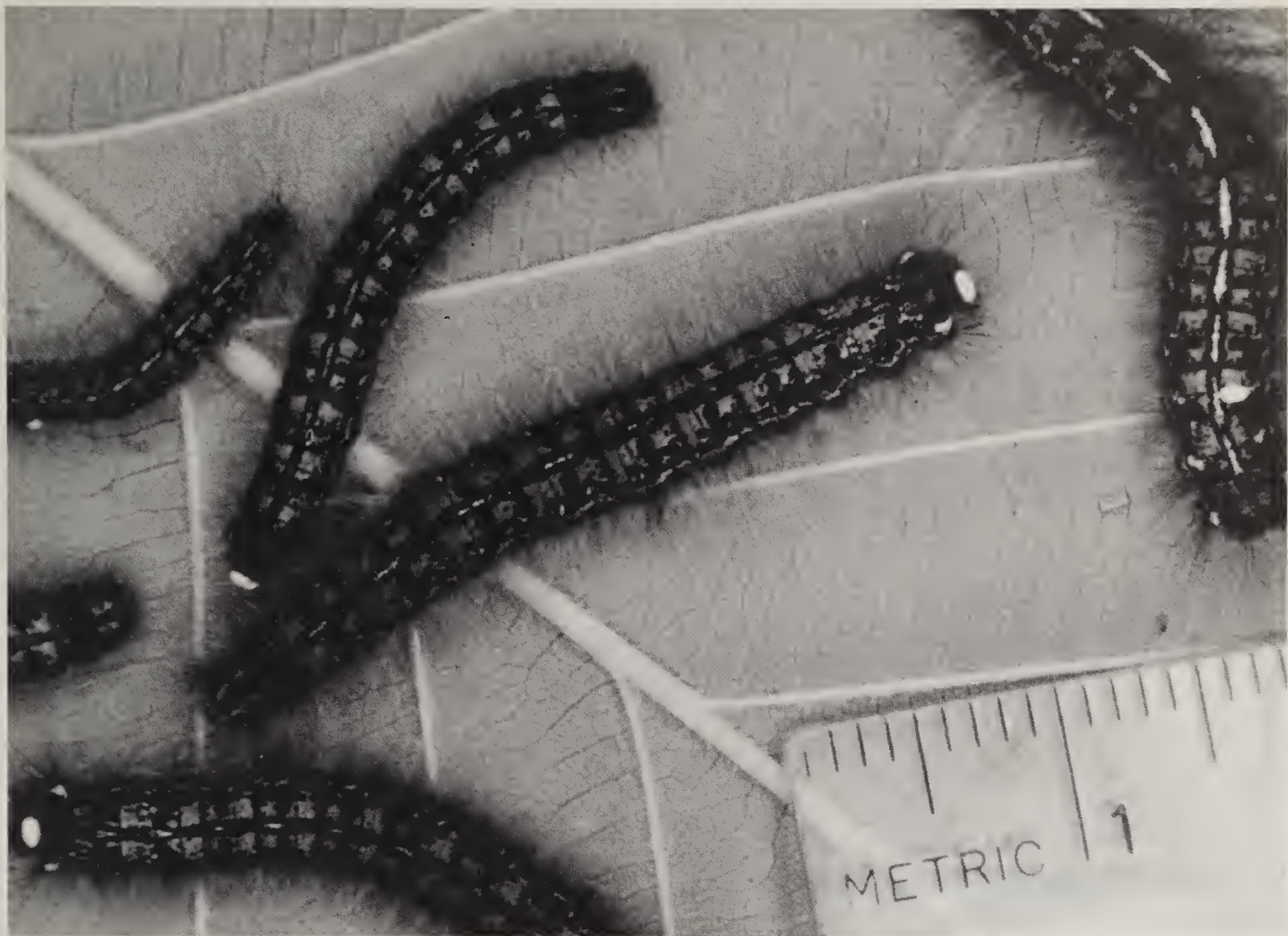
The purpose of this article is to familiarize you with the mysterious ways of the tent caterpillar and to outline some of the alternative ap-

proaches to living with the insect. Perhaps some of the rhetorical questions above can be better understood after taking a more objective look at the life histories of *Malacosoma* species. Besides, the only thing the caterpillars are trying to do is maintain a living and leave offspring for the future, and what could be wrong with that?

Tent caterpillars are found in temperate and semi-arid regions of the northern hemisphere. Four species of *Malacosoma* are recognized in Europe and North Africa and two species in northern India. Two species are common to eastern North America (*M. americanum* and *M. disstria*) and another four North American species are restricted to the west with the exception of *M. californicum pluviale* whose range includes eastern Canada. (Stehr and Cook 1968)

General Life History Traits

Malacosoma are univoltine (i.e., their life cycle is complete in one year and generations are non-overlapping), and undergo complete metamorphosis—they have an immature larval or caterpillar stage between egg and pupa (a non-feeding, inactive stage where a form change occurs from caterpillar to winged adult). The



Western tent caterpillars with tachinid fly eggs on their heads.

photo: author

egg phase of *Malacosoma* ranges from mid-July until the following spring. Within two to three weeks after a female moth oviposits (lays eggs) the caterpillars develop completely, and thus, are dormant or in diapause for the next eight months. (Fig. 1)

Larval development

The most active and gregarious life history phases occur from the vernal equinox through the summer solstice when the larvae develop, pupate and breed as adults. If egg hatch is not exactly in tune with the beginning of bud opening on host trees, the colonies may sustain themselves by feeding on froth (spumaline) from the egg mass, partly opened resin-coated buds and dew or rain water. Even to just hatch, caterpillars must eat through chorion and spumaline, so it is not surprising that they might continue to feed on the egg mass remnants if other food is not available. As soon as the buds burst, the caterpillars begin to consume the epidermis and later the whole leaf of their host tree.

Caterpillars bear conspicuous hairs when born and are less than 2 mm long. With each successive molt or instar the markings of the

full-grown caterpillars become more distinct and noticeable. Most individuals have five instars before pupating, the time between which varies from tree to tree. Tent caterpillars are cold-blooded or ectothermic, nevertheless they grow very fast. During the day when the weather is nice caterpillars stay outside the tent, occasionally eating (they feed more commonly at dusk and dawn). At night and on rainy, cold days the larvae reside inside their tents. This trend reverses itself as the days grow warmer and the larvae grow older. Total consumption of leaves and absolute growth rates are greatest during the fourth and fifth instars, yet consumption and development relative to a larva's initial size at the start of an instar are not that different from one instar to the next. Tent caterpillars are not very efficient at converting plant matter to biomass, and so in order to grow they must consume lots of foliage and produce a large amount of frass (caterpillar excrement).

Tent caterpillars wag their heads from side to side quite frantically if disturbed. This is because the only position on their larval bodies upon which tachinid flies may successfully lay

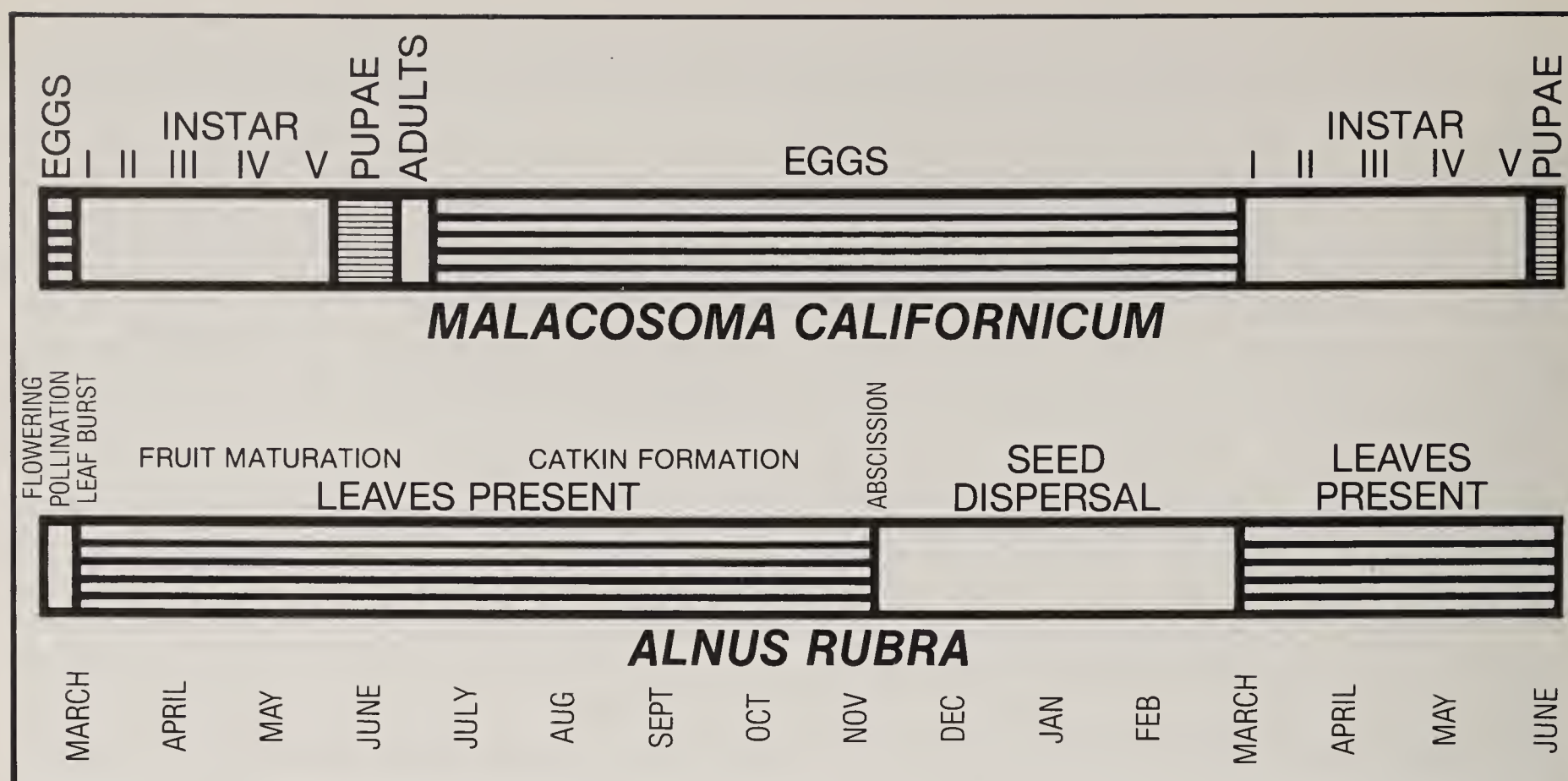


Fig. 1) Life history diagram comparing the western tent caterpillar with a common host, *Alnus rubra*, red alder.

their eggs is on the caterpillar's head—if laid anywhere else on its body, the caterpillar will simply chew them off. Another interesting trait of tent caterpillars is their ability, when disturbed, to drop from a tree and hang on silk, or even to drop to a lower leaf or to the ground.

Pupation and Sex Ratios

Pupation occurs in late June and early July, and adults (moths) emerge in July, mate and oviposit. As pupae the differences between the sexes becomes obvious (i.e., they are sexually dimorphic). Male larvae are much smaller than female larvae and it takes males a shorter time to reach the pupal stage. The data I have obtained support the belief that the ratio of males to females is about one at birth, but may become skewed toward more males with lower survival rates. For some individuals the colonial life does not end as larvae. I have found multiple pupae wrapped within a single cocoon.

Although I first noticed this phenomenon under experimental conditions, last spring my daughter and I discovered the cocoon-sharing behavior in a natural situation.

Ephemeral Adults

Adult moths emerge after two to three weeks and immediately seek mates. Usually the moths emerge in the later afternoon and during the evening. The adults are unable to eat because they lack functional mouth parts and die a few days after emergence from their pupal cases and cocoons. Adult moths are extremely active

and may disperse over large distances. Females mate but once and will lay a single egg mass around a twig, or less commonly, upon some inert object such as a piece of lumber or a brick wall. In contrast, the behavior of adult males is sometimes promiscuous. In experiments in which I have placed adults together in gallon jars in various ratios of males to females, I have observed that some males mate with up to three females. This polygamous behavior can result in as many as three egg masses from three monogamous females sired by a single male. On the other hand, I have suspicions that some males are very boring, (or bored), refusing to mate at all.

Population Biology

Tent caterpillars are primitively social, living gregariously in colonies which, at least ini-



Two pupae sharing a cocoon.
The larger is female.

photo: author

tially, consist mostly of siblings. Adaptive advantages to a colonial life-style include tent building, amelioration of thermal environment (thermoregulation), and cooperative foraging behavior associated with chemical trail communications or trail blazing.

Tent construction

Despite the common epithet, not all species build tents. Of those that do build tents, not all build them in the same way or make the same use of them. *Malacosoma americanum*, *M. californicum* and *M. incurvum* build large, complex tents which may be utilized most of their larval lives. Often the initial tent is abandoned and two or more tents are constructed on outer branches of the host tree. The shape and form of a tent varies from colony to colony, especially among the species that build complex tents. Tents may be elongated and small or large and compact (Wellington 1974). The tent appears to serve as a home with many functions. Complex tents are utilized for molting, thermoregulation, refuge from storms and escape from predators.

Thermoregulation

Although poor insulators, tents maintain higher temperatures during the day than ambient air. A less obvious means of increasing body temperature is to sun-bathe in clusters upon the surface of tents. Tent caterpillars can overheat, especially in May and June. The tent, as well as the tree, provides a whole range of temperature regimes that allows the larvae to seek out optimal microenvironments.

Trail-blazing

Trail-marking by caterpillars allows for less active larvae to find food by following the trail of another more active caterpillar. The chemical agent responsible for the caterpillars' recognition of each other's trails is ether-soluble and is effective with or without the silk. Caterpillars seem to be able to distinguish the trail of a caterpillar returning from a successful foraging activity from that of a caterpillar returning with an empty gut. (Fitzgerald 1983) The social system of tent caterpillars is much more complex than originally believed.

Massive Outbreaks

All *Malacosoma* spp. have cyclic population outbreaks that vary from between three to five years to as long as 15 to 20 years, or more. Several theories have been proposed to explain



*Courtship occurring a few hours after emergence.
Male has fuzzy antennae.*

photo: author

these rampant population cycles. Some theories involve the nutritional quality of foliage which may change due to environmental and historical factors (e.g., succession or past grazing), while other theories deal with the direct effect of weather on the larvae and eggs, the role of predators or the polymorphic behavior of individuals.

Outbreaks of *Malacosoma* in North America were first noted as long ago as 1646. Recent outbreaks have been observed in isolated, undeveloped areas such as aspen forests in the Rocky Mountains, so it is assumed that the causes of the outbreaks are independent of human presence. Our activities, however, have altered areas and successional trends have often resulted in replacement of former ecosystems with species that are preferred hosts of tent caterpillars. Larvae seem to do very well during warm, humid springs when temperatures never drop to extremely low levels. Hodson (1962) has suggested that late springs followed by moderate temperatures are important factors that might result in population increases of *Malacosoma*. Outbreaks persist from one to four years in any one area. Population densities may be decreasing at one locality, while increasing at sites just a few miles away. In the mid-seventies we had such a situation in the Puget Sound area when caterpillars were found throughout the region, yet the densities of the insects and the timing of the outbreaks varied from one location to another. In contrast, for the first half of the eighties, caterpillars were virtually absent from western Washington. For the last two years, the caterpillars have made themselves all too conspicuous, being very prevalent in southern Puget Sound, on the Kitsap Peninsula and north of Everett. They became more noticeable in

Seattle last spring and are apparently increasing rapidly in the city at this time.

Species Found in the Pacific Northwest

Three species of tent caterpillars are found in the Northwest. Two of these, the western tent caterpillar (*Malacosoma californicum pluviale*) and the Pacific tent caterpillar (*M. constrictum constrictum*) are native, while the third, the forest tent caterpillar (*M. disstria*) is a species introduced here from eastern North America. The western tent caterpillar is the most common species in this area. East of the Cascades, this species is often found grazing on *Purshia tridentata*. The western tent caterpillar is the only species in the Puget Sound area that builds a complex tent. The Pacific tent caterpillar does not build large, conspicuous tents—the tents are used only during molting. This caterpillar feeds only on oaks (which in southern Washington and Oregon means *Quercus garryana*), and ranges from the Pacific Northwest to southern California and Baja. It is not found in eastern North America, but bothersome questions arise as to what would happen to the beautiful oak-hickory forests of the east should it ever become established there. The forest tent caterpillar, in spite of its common name, is the only species of *Malacosoma* in North America which does not build some kind of tent. However, before shedding its exoskeleton it spins a matting of silk on a branch or trunk which it attaches itself to when molting. When the eastern forest caterpillar mixes with a family of western tent caterpillars, it readily joins the colony. This intruder stands out as a blue and white idiosyncrasy mixed amongst the orange and black of the western tent caterpillar. *Malacosoma disstria* has the widest range of host trees of any North American tent caterpillar.

What Tent Caterpillars are Not!

Tent caterpillars are not fall web worms (Arctiidae: *Hypantria cunea*), yet many people confuse them with tent caterpillars because of the similarities in their life histories. They both build tents, are colonial, forage on the same tree species and undergo 5-6 instars. Unlike tent caterpillars, fall web worms are active during late July and mid-September. Their young larvae are translucent to white (becoming colored



Elongate tent.

photo: Tom Boyden

only in later instars), they do not undergo large outbreaks nor do they seriously damage large trees.

Tent caterpillars are also confused with gypsy moths (Lymantriidae: *Lymantria dispar*) and armyworms (Noctuidae: *Spodoptera frugiperda* and *Pseudaletia unipuncta*). Gypsy moths have life histories similar to tent caterpillars, yet do not build any silk structures and are solitary. Army worms exhibit mass migrations during outbreaks similar to the processional behavior of *Malacosoma* spp. (Fabre 1916) The major reason these moths have been confused with tent caterpillars seems to be their common habit of outbreaking and totally defoliating trees.

Tent caterpillars do not transmit disease to humans. The caterpillars do not bite and they are not poisonous. Only where trees are stressed does complete defoliation by tent caterpillars result in the death of the host tree.

Good Things to Say About Tent Caterpillars

Tent caterpillars do have some positive aspects! During massive outbreaks in areas with closed canopies of deciduous trees, caterpillars



Compact tent.

photo: Tom Boyden

can serve as a mechanism for thinning a stand. This action may increase productivity of the trees over the long-run and perhaps allow conifers and other plants to become established in the understory, thus increasing the number of species that are able to coexist. Tent caterpillars, due to their low efficiencies of conversion of ingested matter to biomass, excrete lots of frass which results in more rapid mobilization of nitrogen in an ecosystem. In addition, these organisms provide a marvelous research creature for helping us to understand the origins and evolution of social systems in the insect world.

Methods of Control

Tent caterpillars are primarily a nuisance—not a pest—as they do not actually kill trees and persist in large numbers for a few years at most and do significant damage for only a brief period during the growing season. Various methods are available for controlling them locally, yet no reasonable means exists for controlling them on a regional basis. The caterpillars appear to be held in check by natural enemies such that any attempts at eradication of the herbivore from the Puget Sound area would be futile and unnecessary. Methods of controlling on a local basis include release of natural enemies, mechanical control based on an understanding of the life history of the organism and spraying with chemical insecticides.

Natural Predators

Tent caterpillars have many natural predators. The pathogen which probably does the most damage to tent caterpillars is nuclear polyhedrosis virus (NPV). The virus has inclusion bodies, meaning the virus particles are enclosed in protein crystals. The viral infection may induce a change in larval behavior whereby the caterpillar climbs to the highest point available just before dying. The integument (outer covering of the body) ruptures after death, releasing millions of inclusion bodies that contaminate the leaf surfaces thus enhancing the chance that other larvae will become infected with the disease. This virus has the potential to wipe out entire colonies, but is ineffective in sunny locations since sunlight destroys it (Smalley 1966). The relative invulnerability of the virus in shaded spots may explain why the caterpillars do well in habitats such as abandoned orchards and strip mines.

A natural bacterial pathogen, which is available commercially, is *Bacillus thuringiensis*. This control agent is selective in that it kills only caterpillars and is relatively safe for other insects, fish, birds and mammals. It is necessary to spray the foliage with this organism since larvae must eat moderate amounts of the bacteria in order for the application to be effective. The caterpillars will become sick immediately and stop feeding, yet will not die until a few days after the application. Thorough coverage of foliage is necessary and spraying should not begin until early signs of leaf damage appear.

Other effective natural controls include many parasitoids which deposit eggs on or within the caterpillar's body. When the eggs hatch, fly or wasp larvae begin feeding on the caterpillar internally. The tachinid fly is one such parasite. Others include two families (Braconidae and Ichneumonidae) of parasitoid wasps, common feeders on tent caterpillar larvae during outbreaks. The genera *Bracon* and *Rogus* deposit eggs within the larvae and induce the caterpillar to migrate to the base of trees, or other hard objects, where they shrivel and die. The most common narrow-waisted ichneumonid is the genus *Hypostater*, which acts in a manner similar to the braconid parasitoids.

Mechanical methods

Probably the most effective way to control tent caterpillars locally is to remove their egg

masses from the trees during diapause. The eggs are easy to find on small trees, yet difficult, if not impossible to find on large ones. They can easily be removed by hand or pruned and then crushed. The caterpillars are more readily spotted (especially on larger trees) after they hatch, and so perhaps the simplest way to remove them is to watch a tree with binoculars in early spring, and then remove and destroy their nests by stripping or pruning them from the branches. Tent caterpillars are easy targets when they are in their first to third instar stage, and the best time to remove them is during the evening and early morning when the larvae return to their tents. Larvae that have reached the fourth and fifth instar stage may have dispersed, and may already have inflicted heavy damage upon the trees by this time.

Chemical Insecticides

Spraying with chemical insecticides is a method of last resort. It is the most expensive method for attempting to control tent caterpillars. Chemicals which are registered and recommended by King County and the State are Malathion, Diazinon and carbaryl (Sevin). It is generally agreed, that carbaryl sprays do quite a bit of damage to flowering plants since bee pollinators carry residual material from this spray back to their hives which results in the deaths of their co-workers. If you must spray with insecticides, it is best to do so early in the morning or late in the evening when the bees are less active. As is true with mechanical removal, spraying is most effective when the caterpillars are newly hatched and most likely to congregate. Chemical insecticides are not selective and thus kill natural predators as well as the caterpillars. Spraying with chemical insecticides for tent caterpillars in August or September is doubly insulting in that one is not only spraying a relatively harmless, misidentified organism (i.e., the fall web worm), but also killing many of the natural predators of tent caterpillars.

Cooperative Neighborhood Approach

In the past one common attempt at controlling tent caterpillars has been for neighbors

to tattle-tale on others when tents appear in some of their yards. At first glance this neighborhood watch approach appears to be based on actions of concerned, noble citizens. Reconsideration, however, reveals a lack of communication and understanding. For instance there have been highly successful group approaches in combatting the pernicious and toxic tansy ragwort (*Senecio jacobaea*) in southwest Washington, where the DNR has sold cinnabar moth (*Tyria jacobaea*) larvae to organized neighborhoods, private corporations and farmers. Such an approach in the early stages of a tent caterpillar outbreak would be a very constructive way of handling this interesting, yet sometimes irritating, herbivore.

Acknowledgments

I am most indebted to B.J.D. Meusse for constructively reviewing this manuscript and to T. Boyden for providing me with two photographs used in this article. Wendel M. Adams, my daughter, was most helpful in assisting me in searching for pupae and in cutting open cocoons. Julia and Gary Gerhard graciously provided me with the details of their Home Owners Association (High Valley) work with the cinnabar moth for which I am thankful. Help has also been provided by G. Orians and D. Rhoades through NSF grant DEB-73-03258. ❧

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Marvin Black

Marvin Black, the Seattle City Arborist, died March 1, leaving a gap that will be difficult to fill. Marvin believed that trees, their selection, placement, and culture were important to a city and its citizens. He promoted a new understanding of the role of street trees in a municipal setting, but his influence on the horticultural world was not limited to the area of Seattle, nor to his specialty. Since his passing, friends and professional acquaintances throughout the world have been remembering ways in which his enthusiasm for things horticultural has touched their lives.

Marvin's fascination extended from the giant redwoods to the tiniest alpine atop the highest peak. He was committed to furthering the same enthusiasm among his fellows. His fine hand was seen in developing programs of numerous horticultural groups: the American Rock Garden Society, the International Society of Arboriculture, and the Seattle chapter of the English Hardy Plant Society, to mention a few. He was generous with his time and knowledge, inspiring gardeners and future professionals through his busy speaking schedule and his prolific writing for local, national, and international publications. He was currently involved in the preparation of two books.

More lasting than the awards, citations, and accolades, are the quiet, personal memories. Roy Davidson, internationally known plantsman, has written, "Marvin was my friend for nearly forty years. I remember well the nursery of perennial plants he operated outside Salem and the design school that went along with it. His inspiration and helping hand were incentives that will always remain with those who knew him."

His influence will continue beyond his years. We shall miss him.

Nan Ballard

Plants Flowering in the Arboretum, January 2, 1987

Camellia japonica 'Dona Magalhaes'
C. hiemalis 'Shishi-gashira'
C. sasanqua 'Apple Blossom'
C.s. 'Briar Rose'
C.s. 'Dazzler'
C.s. 'Hinode-gumo'
C.s. 'Kentigo'
C.s. 'Kokinran'
C.s. 'Setsugekka'
C.s. 'Tago-no-tsuki'
C.s. single pink, unnamed
C.s. form (21-64)
C.s. form (1462-40)
C. x williamsii 'November Pink'

Daphne laureola
D. mezereum var. *alba*

Erica x darleyensis 'Furzey'
E. herbacea 'Springwood Pink'

Hamamelis x intermedia 'Hiltingbury'
H. x i. 'Winter Beauty'
H. japonica var. *arborea*
Helleborus lividus subsp. *corsicus*

Mahonia x 'Arthur Menzies'

Prunus subhirtella 'Autumnalis'

Rhododendron arboreum hybrid (35-64)
R. mucronulatum

Sarcococca confusa
S. hookeriana var. *digyna*
S. orientalis

Viburnum x bodnantense 'Dawn'

V. x b. 'Deben'

V. farreri

V. f. 'Candidissimum'

V. foetens

V. rhytidophyllum (first flowers)

V. tinus var. or clone

JAN PIRZIO-BIROLI



Camellia Sasanqua '*Apple Blossom*'.

photo: Don Normark



Marshall Island Vegetation and the United States Nuclear Weapons Testing Program

S.P. GESSEL and R.B. WALKER

The authors had the opportunity to study the effects of weapons testing on plants and soils of these atolls from the early 1950's to 1964. They served as consultants to the Laboratory of Radiation Ecology at the University of Washington then under the direction of Dr. Lauren Donaldson. They made numerous visits to the atolls during these years and developed many internal reports. They had the opportunity to return to Bikini and Rongelap in February 1986 as consultants to the Lawrence Livermore National Laboratory to help in developing information for the rehabilitation of Bikini atoll. They were able to return to many of their specific study sites and therefore record changes over the twenty-two year period since their last visit.

To provide the proper setting for this story we ask you to imagine yourself on a warm palm-fringed beach over 5,000 miles southwest of Seattle in a Micronesian group known as the Marshall Islands. We make it specific by placing the beach on Bikini atoll (Fig. 1). Like all atolls, this one consists of a necklace of islands connected by a coral reef, and surrounding a shallow salt water lagoon (Fig. 2). The entire formation is perched on top of a coral mound which covers a submerged mountain. The shallow warm water above the mountain has allowed corals to grow and develop the present framework.

Bikini and associated atolls in the Marshall Islands became widely known during the United States nuclear weapons testing program in the Pacific from 1948 to 1959. They have been the subject of several reports and discussions over the past years including two *National Geographic* articles this year that have dealt mainly with the native peoples and the efforts to reorganize their societies after years of disruption. This short article will describe the atoll

environment, soil and vegetation. In the Fall, 1987 issue of the *Bulletin* we will consider the effects of the testing program on vegetation and the recovery of disturbed areas.

A few generalities are in order before describing the vegetation. Bikini and Rongelap atolls differ in relationship to weapons testing activities. Rongelap was affected by radioactive fallout in 1954 but not by construction, heat, or blast damage. Rongelap was also found suitable for human habitation except for a period between 1954 and 1957. The native population was there through all of our visits, except for that of 1986 as Green Peace had moved the people to Kwajalein atoll in December 1985. Each of the atolls is a sovereign nation, although united in a federation (the Republic of the Marshall Islands) with defense and foreign relations handled by the United States. An atoll population is small, 250 in the case of Bikini. Nor is the land area large—4 square miles at Rongelap and 2.3 square miles at Bikini, and only a few hundred acres are available for crop production.

Bikini atoll was the site of much construc-



Coconut grove on Rongelap. An established plantation, used by the native population for farming copra. photo: author

tion and testing activity up to 1962. The Bikini people left in 1949, came back briefly in 1974 but had to leave because of high levels of radioactivity in some of the locally grown food. A major effort is now underway to correct this problem and enable them to return permanently to Bikini. We will describe these efforts in a later section.

The reader should keep in mind that these atolls have been previously under both German and Japanese jurisdiction. Some of them, such as Eniwetok and Kwajalein were sites of intense battles during World War II and suffered much destruction. Bikini and Rongelap were spared military action but had extensive coconut plantation development under both German and Japanese rule. Therefore, on each atoll man has had a substantial influence on vegetation modification, especially on the larger islands. However, each atoll does have small islands unsuitable for permanent habitation where vegetation has not been changed by man, but where natural forces have brought about change.

Vegetation of the Marshall Islands

Because of the isolation of the islands and the extreme nature of the habitat, the number of plant species is relatively few. A list of the predominant species with notes on habitats is given in Table 1. Most of these species are native in the island environment but a few have been introduced by man in attempts to bring additional food or floral plants to the area. There

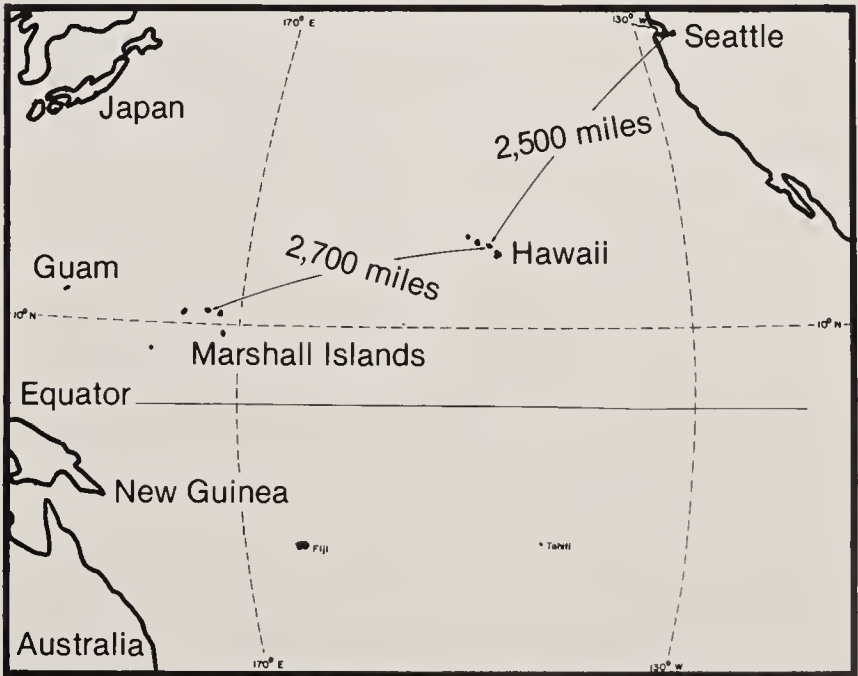


Fig. 1) The Marshall Islands—5,000 miles SW of Seattle, 10° N of the Equator.

Species	Family	Habitat Notes
Tree form		
<i>Bruguiera conjugata</i>	Rhizophoraceae	Tidal or wet areas
<i>Cocos nucifera</i>	Palmaceae	Village areas-plantations
<i>Cordia subcordata</i>	Boraginaceae	Occurs in thickets—poorer soils
<i>Ochrosia oppositifolia</i>	Apocynaceae	Wooded central areas
<i>Pandanus</i> sp.	Pandanaceae	Widely over islands
<i>Pisonia grandis</i>	Nyctaginaceae	Good soils, island centers
<i>Soulamea amara</i>	Simarubaceae	Scattered trees
<i>Terminalia litoralis</i>	Combretaceae	Scattered behind beach or shore rocks
<i>Tournefortia argentea</i> (formerly <i>Messerschmidia</i>)	Boraginaceae	Disturbed soil—wide occurrence
Tree-like to Shrubby		
<i>Dodonaea viscosa</i>	Sapindaceae	Thickets in disturbed areas
<i>Guettarda speciosa</i>	Rubiaceae	Very common—beaches to interior
<i>Morinda citrifolia</i>	Rubiaceae	Near villages and coconut plantations
<i>Pemphis acidula</i>	Lythraceae	Behind fringe vegetation
<i>Pluchea odorata</i>	Compositae	In disturbed areas near villages
<i>Scaevola frutescens</i>	Goodeniaceae	Very abundant—forms fringe vegetation at beaches and thickets over many areas
<i>Suriana maritima</i>	Surianaceae	On windward beaches
<i>Tournefortia argentea</i>	Boraginaceae	Disturbed soil—common
Shrubs		
<i>Clerodendron inerme</i>	Verbenaceae	Near settlements or coconut plantations
<i>Pseuderanthemum atropurpureum</i>	Acanthaceae	Village areas
<i>Sida fallax</i>	Malvaceae	Clumps around coconut groves
Understory plants		
<i>Boerhaavia</i> sp.	Nyctaginaceae	Often under <i>Pisonia</i> —shaded areas—variable soil
<i>Portulaca</i> sp.	Portulacaceae	Poorer soil—open
<i>Tacca leontopelaloides</i>	Taccaceae	Good soil under coconut
<i>Triumfetta procumbens</i>	Tiliaceae	Spreading stoloniferous cover—open areas—beaches
Vines		
<i>Ipomea alba</i>	Convolvulaceae	Spreading vine in many areas—disturbed sites
<i>Cassytha filiformis</i>	Lauraceae	Parasitic—vine like over other plants
<i>Canavalia microcarpa</i>	Leguminosae	Spreading under coconuts
Grass—grass-like		
<i>Cenchrus echinatus</i>	Poaceae	Village areas—plantations
<i>Chloris inflata</i>	Poaceae	Coconut areas
<i>Eleusine indica</i>	Poaceae	Shade of coconuts
<i>Eragrostis amabilis</i>	Poaceae	Woodland glades
<i>Fimbristylis atollensis</i>	Cyperaceae	On poorer areas
<i>Lepturus repens</i>	Poaceae	Poorer-disturbed areas
<i>Thuarea involuta</i>	Poaceae	Shaded, wooded areas
Ornamental-food		
<i>Artocarpus altilis</i>	Urticaceae	Trees in village areas
<i>Carica papaya</i>	Caricaceae	Village areas
<i>Cocos nucifera</i>	Palmaceae	Plantations—village areas—otherwise scattered groves
<i>Crinum asiaticum</i>	Amaryllidaceae	Settled areas—cemeteries
<i>Hibiscus tiliaceus</i>	Malvaceae	In villages
<i>Plumeria rubra</i>	Apocynaceae	Village areas

Table 1) Common plants of the Marshall Islands.

are very few common names in English, so we will refer to them by genus name, just as you would the rhododendrons here in the University of Washington.

Tournefortia, *Guettarda* and *Scaevola* are present on all islands, especially near the beaches and can be considered as initial plants. The dry fruits of all of these float and are widely

dispersed by sea water. In fact, the seeds of *Tournefortia* do not germinate under the parent plant, but do establish readily after deposition on bare sandy beaches. Exposure to sea water seems to enhance germination. In addition to water dispersal, the fleshy exocarp of *Scaevola* fruits is attractive to birds such as the Winter-Migrant Curlews, and the seeds are deposited along the beaches in their droppings.

Accretion of sand often occurs to islets, so that they enlarge even over a matter of decades. The *Tournefortia* and *Guettarda* are relatively long-lived trees; scattered older specimens may be found in the interior of islands associated with the bird-dispersed *Pisonia*, which presumably established later after the island enlarged.

Each island with sufficient size to develop a vegetative cover generally has a range of habitats and thus different plants. The seaward beaches, exposed to almost constant wind, moving sand, salt water and salt spray are colonized by *Scaevola*, *Tournefortia* and *Suriana* along with grasses and sedges. The woody plants grow in height and form an effective windbreak which

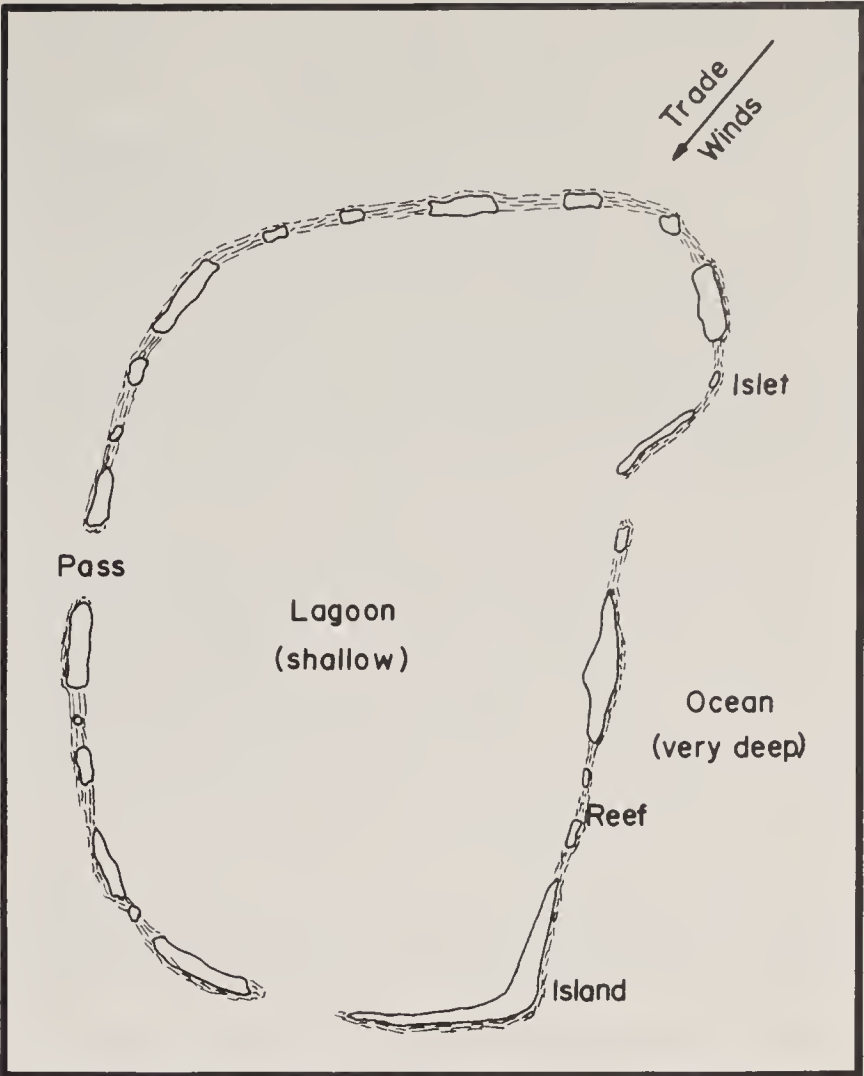


Fig. 2) An atoll consists of a ring of islands connected by a coral reef, surrounding a shallow lagoon, which may be 30-40 miles across, while the land surface may be only a few square miles.



A new sand strip emerging from the ocean with vegetation taking hold. Kabelle Island on the Rongelap Atoll. photo: author

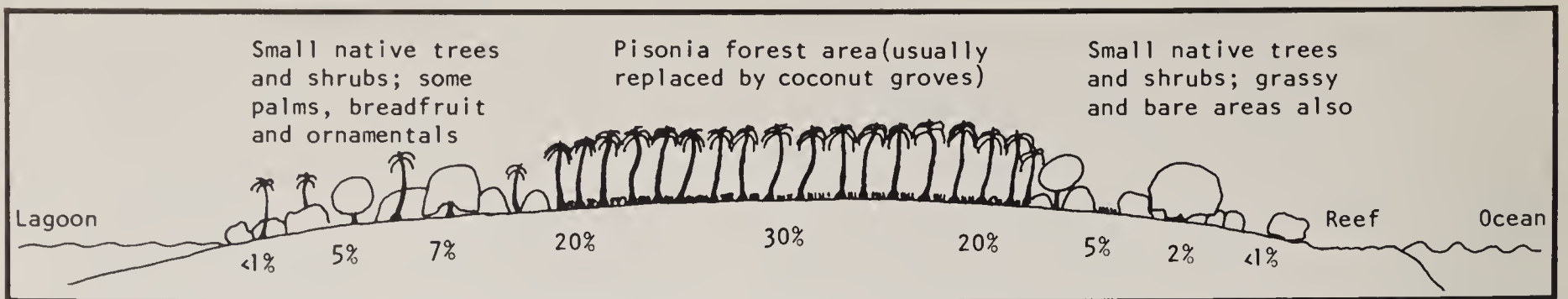


Fig. 3) Profile of an atoll, showing vegetation pattern and expected percentages of soil organic-matter contents. The center is seldom more than 10 feet above sea level, but can be seen from a distance because of the palms which may reach a height of 50+ feet.

then allows development of a more diverse vegetation in the island interiors. Substantial rain during the wet season washes much of the salt from the surface soil and this, along with fertilizer contributions of many sea birds nesting in the vegetation, begins the development of a much more fertile soil which can support plants. Forests of *Pisonia* trees reach their full development in the central parts of the islands, as well as large coconut trees either planted by man, or by natural drift. The general association of soil and vegetation across an atoll island is illustrated in Figure 3.

The lagoon side of an island has less dramatic changes in environments and vegetation because of some shelter from wind and water. However, the fringing vegetation is different from that of the interior, in species as well as in vigor of development. On a few of the islands some of the more protected lagoon pool areas have *Brugeria* (mangrove) colonies.

Over a time sequence any island, depending on its size, reef location, and relationship to human activity, will have a distinctive vegetation

and soil pattern. The more developed and productive associations will be in the central part and the less around the perimeter. As none of the land surfaces are more than 10-12 feet above sea level, the entire surface of an island is subject to inundation during typhoons. This record is clearly apparent in the soil sequences of buried soil horizons. We have encountered as many as eight distinctive soil horizons in a depth of only six feet. In some cases distance between horizons is 12-18 inches, indicating a substantial burial of existing soil and vegetation by a sand cover. The natural vegetation has obviously been able to recover from repeated flooding by salt water and burial by sand layers.

More to Come

In the Fall, 1987 issue of the *Arboretum Bulletin* we will compare specific instances between the period of 1960 to 1986 and draw conclusions about the effect of the United States Weapons Testing Program on the vegetation of the Marshall Islands. 🌿



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In The Arboretum

The new year began with the return of our Grounds Supervisor, Richard Hart. After a short time to refamiliarize himself with the Arboretum and all its changes, he's well back into the swing of things. We welcome him back and wish him another fifty-plus years of good health.

Meanwhile, a mild winter is permitting work to continue at an uninterrupted pace. The ambitious south entrance renovation project is near completion. This area encompasses: the Japanese Garden parking lot landscape where quite an interesting Maple collection resides; a cascading creek with adjacent rock work along the east side of Arboretum Drive; the rockery on the west side of the Drive and continuing up the Boulevard, where several splendid live oaks are to be found; and finally, the South Woods border following along the west side of the Drive. To the amazement and satisfaction of the grounds crew, this project provided many pleasant surprises and new vistas in all directions. Among the thrilling discoveries was massive rock work buried for years under either an accumulation of creek deposits or overgrown groundcovers and duff. A magnificent Madrona grove bordering the South Woods was unveiled. More could be said, but please go and see it all for yourselves. We—horticulturists Phil Renfrow, Bob Hilzinger, Fred Mauch, and myself, and arborist John Hushagen—hope you enjoy the results of our work.

Other noteworthy grounds' renovation

projects either complete now or in various stages of completion include the Spindletree/Boxwood collection, Lynn Street Arboretum entrance (area west of the footbridge), and the landscaped slope bordering our equipment/crew facilities.

Dean Powell and Barbara Engler of the Greenhouse/Nursery crew are diligently preparing for the possible renovation of the Arboretum Greenhouse. In addition, Dean can be found doing pruning and clean-up of the nursery. He has also begun cleaning out the headhouse in preparation for the new construction. Barbara can be found planting and maintaining the lath house and cold frames, although prior to this time, when she still wore a cast on her wrist, she worked on formatting plant records for future computerization.

We wish to acknowledge Bob Baines, Ray Rohman, and Myung Kim, the city crew, for doing a fine job of keeping the turf maintained and the Arboretum a safe and litter-free environment for all. Last, but not least, the Japanese Garden wouldn't be the magical place it is without the sole wizardry of Tim Gredon, also of the city crew. By the way, now that spring is here, the garden is once again open to the public. 🌸

David Zuckerman
Gardener in the
Arboretum

Book Reviews

Manual of Cultivated Trees and Shrubs, Vol. II (1985), E.-Pro. Gerd Krussman; Translated by Michael Epp. 445 pages. Timber Press, Portland, Oregon. Price \$65.00.

The arrangement of this second volume follows that of Vol. I (reviewed in the *Arboretum Bulletin*, Fall 1986), and contains the same information in its opening pages, namely botanical terminology in five languages, hardiness zone maps, abbreviations for other reference works, etc. The number of pages is approximately the same, as are the figures (322 line drawings or maps), and the photographic plates (176). The number of genera included is much increased, extending from *Eccremocarpus* to *Protea*. Some of the genera mentioned, such as *Ficus*, *Grevillea*, *Hakea*, *Melaleuca*, *Nothopanax*, *Passiflora* and *Phoenix* are hardy only in Zones 9 and 10, and consequently cultivated in California, Florida and similar areas. This does, of course, widen the scope of the book and make it more useful for semi-tropical regions.

However, the list of those genera grown in Pacific Northwest gardens is much larger than that for more southern climates and of great value because of the extraordinary amount of information contained in the text as well as in the drawings and other illustrations. For example, in *Erica* there is a key to the European species and hybrids as well as a separate listing of the South African species. In *Forsythia* there are illustrations of both flowers and leaves, with descriptions of the cultivars. In *Hebe*, 34 species and 20 cultivars are described, with drawings of twigs or inflorescences of a number of species. In *Hedera*, there is first a key to the species and then a grouping of similar clones of *H. helix* by habit, leaf color and form, with three full-page plates of drawings of branches and foliage and seven black-and-white plates of mature plants or of foliage of the species. *Hypericum* is treated and grouped according to the work of Dr. N.K. Robson of Kew, the recognized authority on this genus of shrubs. In the hollies, genus *Ilex*, there are descriptions of many cultivars of *I. aquifolium*, the hybrid forms of *I. x altaclerensis*, and

of clones of the Japanese holly, *I. crenata*, but not of the native American holly, *I. opaca*. For these we are referred to the *National Horticultural Magazine's Handbook of Hollies*, published in 1957. *Lonicera* was evidently a favorite with the author, since his treatment of it covers 25 pages, plus six plates which show dried leaves of the species, and 12 half-page drawings of flowering branches or flower parts. With this data we should be well-informed on the honeysuckles in the future! Other genera receiving similar extensive descriptions and illustrations are *Magnolia*, *Mahonia*, *Malus* (5½ pages of cultivars described), *Pieris* (with 22 cultivars), and *Potentilla fruticosa* and its near relatives, having 52 named clones. The mock-oranges, *Philadelphus* species and hybrids, also receive extended attention, with drawing by Dr. S.-Y. Hu of the Arnold Arboretum.

A few factual errors should be noted. The introduction of *Magnolia Kobus* (*M. x kewensis*) 'Wada's Memory' is ascribed to the Arnold Arboretum at Boston, Mass., instead of to the Washington Park Arboretum in Seattle. It was received here as a plant in March 1940, not raised from seeds. *Magnolia x watsonii* is now *M. x wieseneri* Carr., a slightly earlier name. The name *x Osmarea burkwoodii* has been retained in this text, although Mr. P.S. Green showed some years ago that both parents are species of *Osmanthus* and it is therefore properly named *Osmanthus x burkwoodii*. Our native Indian Plum is no longer *Osmaronia* but *Oemleria cerasiformis*.

Some plants which should have been included are the hybrid *Mahonia* 'Arthur Menzies,' described in the *Arboretum Bulletin* in 1967, and the later hybrid *Garrya x issaquahensis*, also published in this journal in 1980. *Illicium parviflorum*, a native of eastern Florida, grew in the Washington Park Arboretum for a number of years and should have been mentioned. The illustration of *Gaultheria* "ovatifolia" on plate 33 is certainly not that species, but probably *G. hookeri*. The lower illustration on plate 9, of *Enkianthus perulatus*, has been printed upside down.

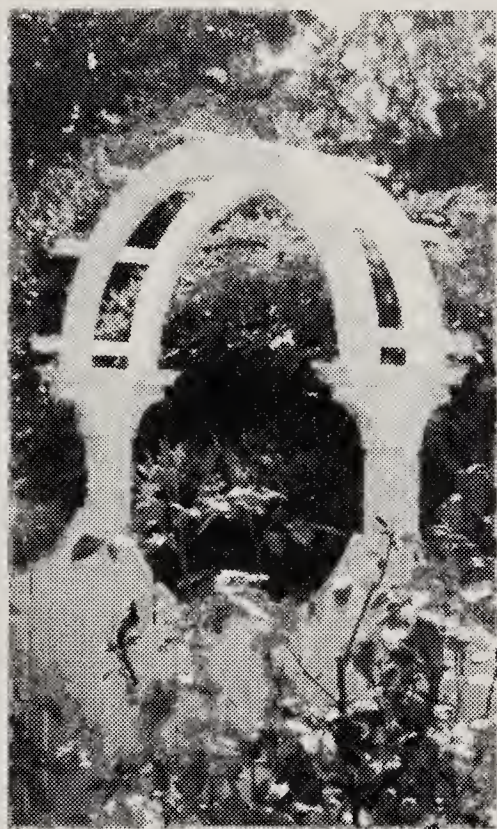
Despite these minor criticisms there is no question but that this is a work of the greatest importance and value to students of woody plants grown chiefly in the northern hemisphere, and will be an authority on the subject for many years to come. We are indeed grateful to the translator and publisher for producing it in such a readable form. Brian O. Mulligan

Manual of Cultivated Trees and Shrubs Hardy in North America, Alfred Rehder. 996 pages. Dioscorides Press, Portland, Oregon. Price \$59.95.

This book is the much-awaited reprint of the second edition of a classic published in

1940. The author was Professor of Dendrology and Curator of the Herbarium, Arnold Arboretum, Harvard University for 40 years. He co-authored over 1,020 volumes, articles, and chapters.

The "Manual" is a basic—one of the truly definitive standard reference books for professionals, students, and amateurs in the fields of botany and horticulture. It lists a total of 486 genera, 2,535 species, and 2,685 varieties distributed among 113 families. The detailed plant descriptions, glossaries, and indices, combined with its accuracy and comprehensiveness re-establishes this volume as an obvious addition to our libraries, both personal and public. ❀



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If you're thinking of including visits to public gardens and arboreta in an upcoming vacation, two new reference books could help in making your plans. . . .

American Gardens: A Traveler's Guide, Brooklyn Botanic Record, Plants and Gardens, 1986.

An update to the 1970 edition, this new guidebook describes 250 display gardens that are open to the public, ranging from botanical gardens to municipal parks and historic gardens. Many photographs, some in color, are included to entice visitors, along with basic information on tours, parking and facilities. Arranged by state and then city, there are seven entries for Washington, including a detailed description of Washington Park Arboretum and a photo of the Woodland Park Zoological Gardens' Rose Garden.

Great Botanical Gardens of the World, by Edward Hyams. London: Bloomsbury Books, 1985.

Nearly 100 color plates, paintings, maps and plans illustrate the rarities of fifty of the world's great botanical gardens. Highlighted is what each garden grows best; Kew and the Arnold Arboretum for flowering shrubs, Longwood for herbaceous perennials, Edinburgh for rhododendrons, etc. Eight North American arboreta are included.

Other New Books

Brooklyn Botanic Garden. *Soils*. Plants and Gardens Series, 1986.

* Brickell, Christopher, and Sharman, Fay. *The Vanishing Garden. A Conservation Guide to Garden Plants*. John Murray, in association

with the Royal Horticultural Society, 1986.

* Chatto, Beth. *The Dry Garden*. London: J.M. Dent & Sons Ltd., 1978.

* *Compendium of Rhododendron and Azalea Diseases*. American Phytopathological Society Disease Compendium Series, 1987.

* Engel, David H. *Creating a Chinese Garden*. Croom Helm Ltd., 1986.

* Fox, Tom; Koeppel, Ian; and Kellam, Susan. *Struggle for Space. The Greening of New York City, 1970-1984*. New York: Neighborhood Open Space Coalition, 1985.

* Krussman, G. *Manual of Cultivated Broad-Leaved Trees and Shrubs*. Vol. III, PRU-Z, Timber Press, 1986.

* Polunin, Oleg, and Stainton, Adam. *Flowers of the Himalaya*. Oxford University Press, 1984.

* Salley, Homer E., and Greer, Harold. *Rhododendron Hybrids, A Guide to Their Origins*. Timber Press, 1986.

* Simpson, A.G.W. *Growing Bulbs*. Kangaroo Press, 1985.

* Stevens, David. *Creative Gardens*. Hamlyn Pub., 1986.

* Special thanks to the individuals and organizations who have contributed these books to our library.



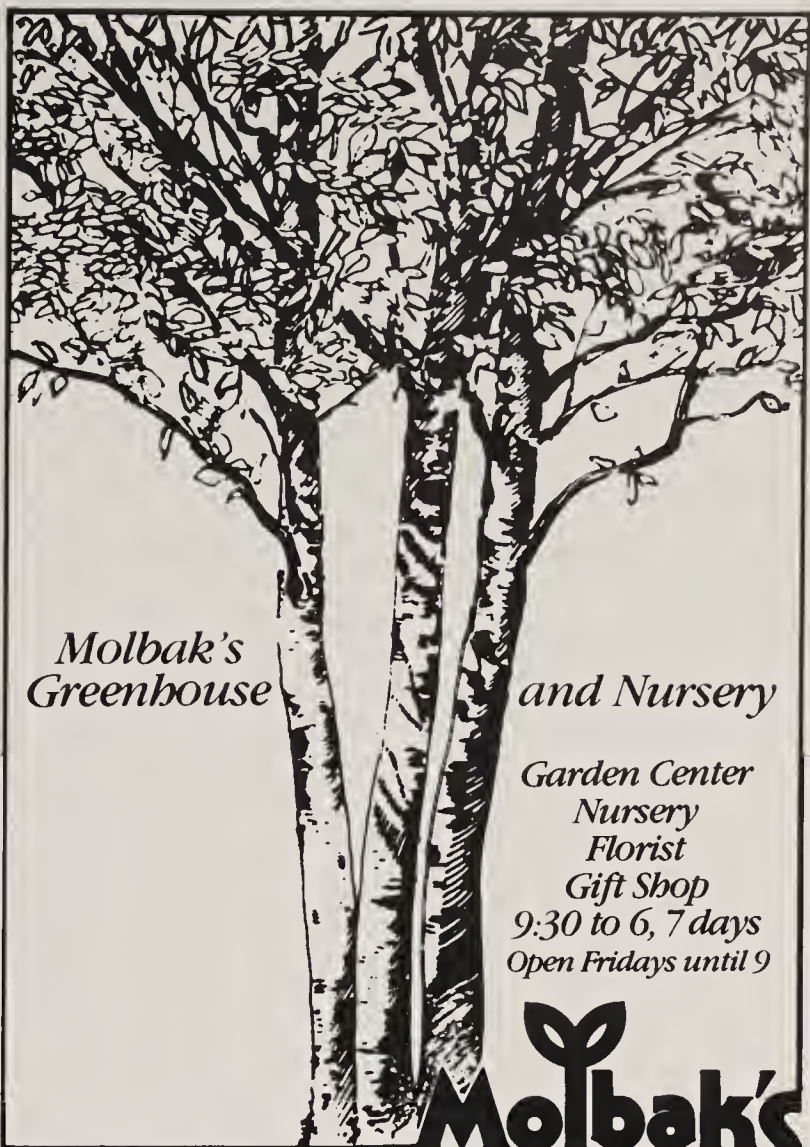
All of these books can be found in the Elisabeth C. Miller Library, Center for Urban Horticulture, 3501 N.E. 41st Street. The library is for reference use only; a copy machine is available for public use. Hours are 9-5, Monday through Friday, with a special Saturday morning this spring: April 25th, 10-1. ❧



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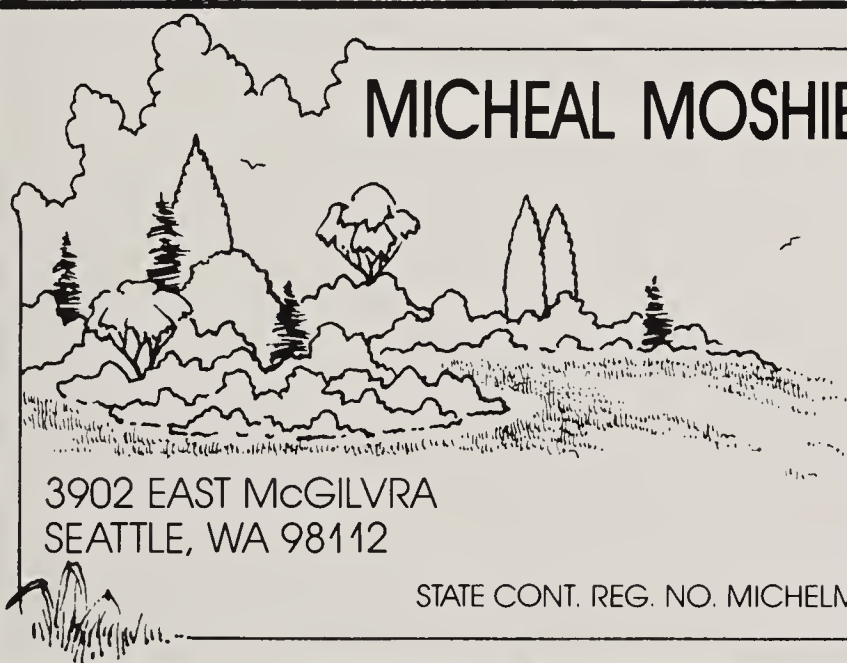
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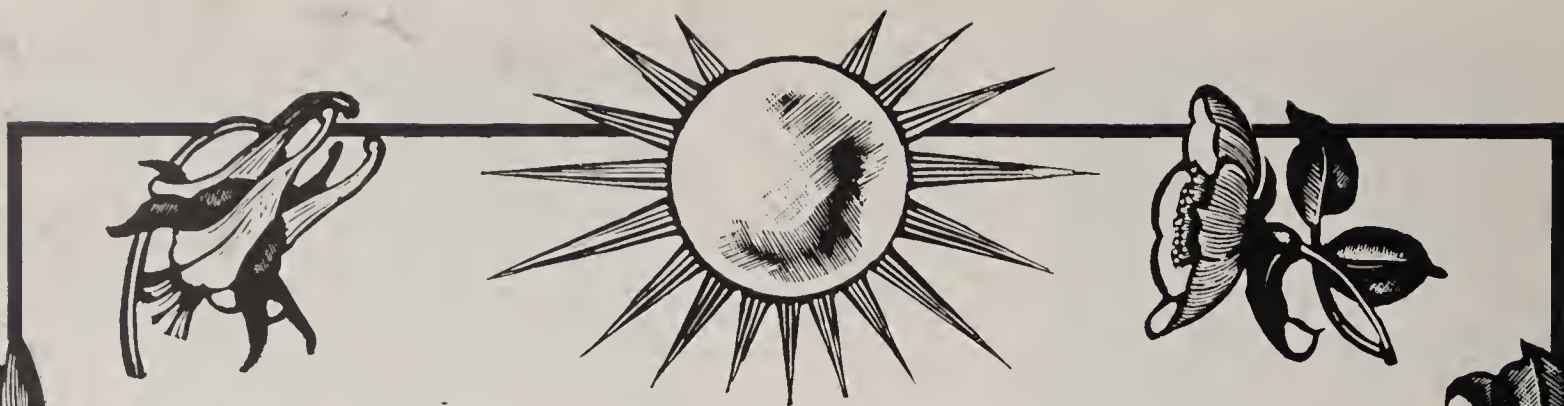
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